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SIMPLE NEPHELOMETER FOR STUDYING TURBIDITY OF TEST SOLUTIONS

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[Figures referred to are appended.]

Great strides have been made in recent years in studying the turbidity of bacteriological and microbiological substances using photo cells (photo nephelometers). Various types of photo colorimeters and photo nephelometers have been used with varying degrees of success.

The author has developed a new apparatus which works on the principle of determining the degree of light dispersion directly in the tested substance thus permitting exact measurements of turbidity of biological substances without decreasing their sterile quality. The construction is simple, and results are accurate. Moreover this direct feature leaves no doubt that it will be widely used for biological studies.

It operates on a differential principle using two photo cells. General schematic views are given in Figures 1, 2, and 3.

The fundamental parts are: illuminating bulb 1, iris diaphragm 2, lenses 3, selenium photo cells 4, test substance containers 5, and an indicating galvanometer 6. Inside the illuminating unit there is a directed-beam bulb ("Osram" 5v6a), which is battery powered. This type bulb has been selected as it permits operation in the 7 to 8-volt range without trouble, thus increasing the sensitivity of the apparatus. The power-supply circuit contains a voltmeter and a rheostat to ensure a stable filament supply (the voltage must be stable when using a nephelometer).

Lenses equipped with iris diaphragms are located at both ends of the illuminating unit (the test model used the objective lens obtained from a "Fotokor" camera).

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After the bulb is activated, the light beam passes through the objective lens in two directions and passes through the test samples. Selenium photo cells K-10 FAN are located at specified angles to the light beam.

Determination of the concentration of any given substance is conducted as follows:

Two test tubes of equal diameter are filled with pure water and set in their proper place. The bulb is switched on and the galvanometer put into operation. The diaphragm (for regulating the light beam) is adjusted so that the galvanometer reads zero. Then the test tubes are filled with several known liquids to check the galvanometer readings. These standard liquids are selected, keeping in mind the probable reading for the unknown liquid. Several readings are taken for each standard liquid in order to obtain accurate data. A calibrated graph is then drawn on the basis of these readings. There are two principle methods in which this can be accomplished:

a. Directly, based on galvanometer readings. In this case concentration is plotted along the abcissa and galvanometer readings are plotted along the ordinate.

b. Based on calculations for extinction. This is computed according to the following formula: $E = \lg i_0 - \lg i$ where i_0 - galvanometer reading for a clear solution; i - galvanometer reading with standard solutions. In this case when calibrating the curve along the abcissa it is necessary to make allowances for concentration, while extinction will be computed along the ordinate.

After the calibration has been completed, work can be started for calibrating the concentration of the unknown solution.

After this preparatory work, the test tubes are refilled with clean water and the zero reading is checked again. Then the unknown solution is put into the test tubes, which are then put in position. The galvanometer needle will naturally deviate. If the original graph was constructed by the direct method, then the quality (or percent) of the unknown solution can be computed directly from the graph.

If the second method was used, extinction has to be computed.

When sterile solutions are being studied, the preliminary calibration tests are conducted on a series of substances having equal light absorbing qualities (these can be placed directly into position).

The test samples in the latter case must be (1) enclosed in clear glass, (2) containers with walls of equal thickness, (3) of equal diameter, and (4) have equal light-absorbing qualities. We used standard bacteriological test tubes: 120-mm long, 17-mm diameter and 18-cc capacity. Test samples are first classed on the basis of the color of the glass in the test tubes, and the ones with the clearest glass are selected. The selected test tubes are then graded according to thickness of glass and outside diameter. Each test tube is then filled with 10 milliliters of water. A further selection is made on the basis of the water level. This final selection is carried out with the aid of a photonephelometer.

The water-filled test tubes are then set in position and the apparatus is activated. The light beam is adjusted so that the galvanometer reads zero. One of the test tubes is then taken out and replaced by one containing either a standard solution or the unknown solution. Before setting this test tube in position, another water-filled test tube is inserted to check the galvanometer reading. Only those test tubes which do not cause any deviation in the galvanometer are used in the further tests.

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The galvanometer used in these experiments was type C IV having 100 divisions (each division equal to 0.11 x 10^{-6} amps) developed by the Leningrad University. Submitted 30 October 1948.

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[Appended figures follow.]

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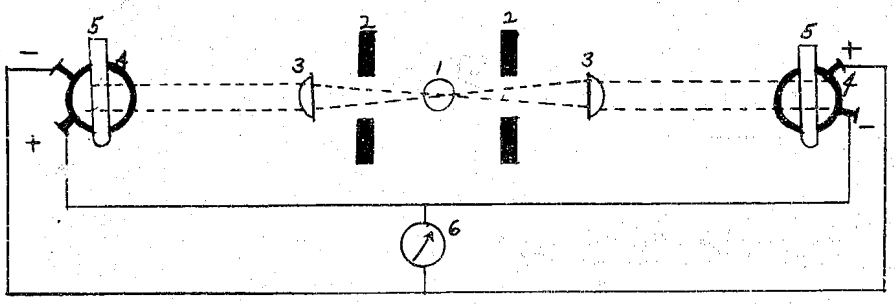

Figure 1

Side View

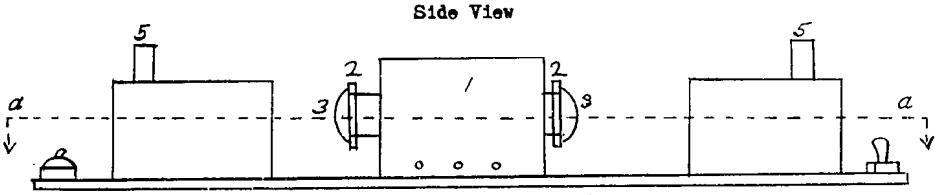

Figure 2

Section Through a-a

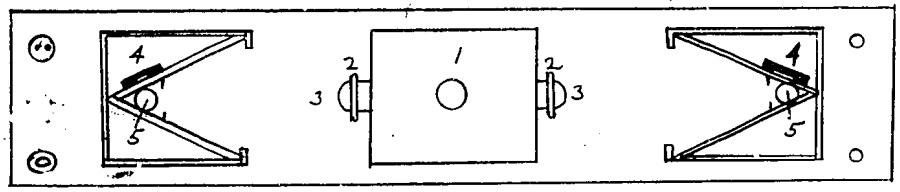

Figure 3 --

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